Rice University
Department of Materials Science and Nano Engineering

MSCI 411: Metallography and Phase Relations
Spring 2014

Description: Study of microstructures that may be observed in metals and alloys, optical metallography (in addition to more sophisticated techniques), and the relationships between structural properties and failures. Required for materials science and engineering majors.

Summary: This course introduces materials from a thermodynamic view point using the phase diagram to show how alloys are constituted in an equilibrium state and then how they can be treated in order to produce useful engineering materials with a spectrum of differing properties. Materials based on iron, aluminum, titanium, and many other elements are considered. The failure of these materials due to overload, fatigue, creep, corrosion, and aging are discussed. With an understanding of the underlying failure mechanisms, the concept of engineering microstructures based on the principles of materials thermodynamics and kinetics to prevent failure is introduced. This course draws from real-world engineering examples, including medical devices, consumer electronics, and machine components to understand the relation between processing, microstructures and performance.

Course Outline:

- Review of basic crystallography, phase diagrams, dislocations and mechanical properties of materials (including strengthening mechanisms).
- Metallography
- Kinetics of structural change: diffusion, nucleation and growth mechanisms, grain growth, recrystallization.
- Common failure modes (including fracture, fatigue, corrosion, creep, environmental stress cracking) and their prevention.
- Manipulation of material behavior by controlling microstructure.
- Failure analysis, including survey of optical, x-ray, and electron microscopy techniques to analyze material structure and fracture surfaces.
- Case studies of the iron-carbon system

Instructors: Ricardo J. Zednik, Ph.D., P.E. (rzednik@rice.edu)
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Lectures: Fridays, 2:00 pm – 4:59 pm (MEC 128)

Office Hours: To be announced. Additionally available by appointment.

Units: 3 units (undergraduate course).

Prerequisite: MSCI 301, or permission of instructor.

Textbooks: None required, however, several references have been placed on reserve in Fondren Library.

George E. Dieter, *Mechanical Metallurgy*, 3rd Edition. McGraw-Hill ©1986

Reza Abbaschian and Robert E. Reed-Hill, *Physical Metallurgy Principles*. 4th Edition, Cengage ©2008

Website: Go to https://owlspace-ccm.rice.edu/portal. Sign in use your NetID and normal password. Go to the "MSCI 411" tab to access course information.

Grading:

Homework	15% (due Fridays at 2:00 pm, before beginning of class)
Midterm	35% (take-home, tentatively due Friday, February 28th, 2:00pm)
Term Paper	50% (due last day of class, Friday, April 25th, 2:00pm)

Late Policy: All assignments must normally be submitted as a hard-copy at the beginning of class. Late submittal of the midterm examination, homework, or term paper will NOT be accepted under any circumstance.

Exam Policy: Although any written references (hard-copy or electronic) may be consulted, no collaboration or communication of any kind is permitted. The open-book midterm examination is take-home, and you will have 1 week to complete it. Calculators and electronic devices are permitted. Late submittal of the midterm exam will result in a score of zero.

Honor Code: All work is covered by the Rice Honor Code. You may collaborate on homework only, but all written work (including figures or plots) must be your own. All references must be appropriately cited. No collaboration is permitted for examinations or term papers. In addition, exams and term papers will require the signed honor pledge.

Students with disabilities:
Any student with a disability requiring accommodations in this course is encouraged to contact either instructor after class or during office hours. Additionally, students should contact Disability Support Services Office in the Allen Center.